DISSERTATION ON

OUTCOME ANALYSIS OF CLOSED INTERLOCKING HUMERUS NAILING IN COMMINUTED AND SEGMENTAL HUMERUS FRACTURES.

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CERTIFICATE

This is to certify that this dissertation entitled "**Prospective study on the closed interlocking humerus nailing in comminuted and segmental humerus fractures."** submitted by **Dr. S.ASHOK** appearing for Part II, M.S. Branch II - Orthopaedics degree examination in March 2010 is a bonafide record of work done by him under my direct guidance and supervision in partial fulfilment of regulations of The Tamil Nadu Dr. M.G.R. Medical University, Chennai.

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INTRODUCTION

Fracture shaft of humerus constitutes 3 % of all bony injuries. The uniqueness in the anatomy, the fracture configuration and the functional significance of the region influences the treatment options.

The humerus is covered by sleeve of muscles and has rich vascularity which helps in fracture healing. The mobility of the shoulder and the elbow joint accommodates for a minimal degree of angulation and shortening. Moreover the limb does not take part in weight bearing or ambulation; hence some amount of shortening is functionally acceptable. But rotational deformity is not tolerated well.

Because of all these inherent advantages of the region, conservative management results in very gratifying outcome. Treatment of humeral diaphyseal fractures has centered on nonoperative techniques, which have been providing excellent functional results. The main disadvantage of shoulder stiffness has been overcome by functional bracing techniques.

Surgical management is indicated in certain situations:

- Closed reduction is unacceptable
- Associated with polytrauma
- Associated with neurovascular injury
- Associated with soft tissue(compound) injury

Operative techniques available are:

- Open reduction and internal fixation with plate osteosynthesis.
- Open or closed reduction and internal fixation with intramedullary fixation.
- External fixation with AO tubular fixators or Ilizarov ring fixators.

Open reduction and internal fixation with plate osteosynthesis has been gold standard for treatment of fractures of the humeral diaphysis. Intramedullary fixation devices have been used very effectively in the treatment of lower limb fractures. Interlocking nailing done with closed reduction has definite advantages over plate osteosynthesis in indicated cases.

AIM OF THE STUDY

TO ANALYSE THE OUTCOME OF CLOSED INTERLOCKING HUMERUS NAILING IN COMMINUTED AND SEGMENTAL HUMERUS FRACTURES.

REVIEW OF LITERATURE

Diaphyseal fractures of the humerus account for 3 % of all the fractures. The treatment concept for these fractures has been evolving over the time period. Historically closed methods of treatment for humeral diaphyseal fractures have centered around one of the two principles

1. Thoracobrachial immobilization

2. Dependency ratio

Thoraco brachial immobilization involved use of the body as a splint. This was achieved using body strapping or by shoulder arm spica cast application. This method of treatment was not reliable for maintaining the alignment of the bone and promotion of bone healing[18].

Caldwell promoted hanging arm cast as a treatment option for management of humeral shaft fractures[7]. These are above elbow casts. They are stipulated to weigh less than 2lbs., in order to avoid distraction. These casts are provided with series of loops, which are used to correct angulation deformities.

U slabs or co-aptation splints were devised based on dependency traction. These are effective methods of treatment but functionally inferior to bracing[7,18,9].

Treatment for humeral shaft fractures was revolutionized by the introduction of functional bracing by Sarmiento[40]. This is a fracture treatment orthrosis made up of lightweight plastic brace fitted with Velcro straps. This has provided excellent long term results with 100% union rate with minimal complications of malalignment, infections, and iatrogenic nerve injury. Various studies have found bracing to be a much superior method of fracture treatment in an otherwise normal individual[40].

Operative intervention was found necessary in patients with malalignment. Klenerman et al [20]and Balfour et al [2]in different studies found that a valgus angulation of more than 15 degrees as unacceptable cosmetically though this was not having any functional disability.

Bell et al proposed that humerus fractures must be fixed in cases of polytrauma[3]. Brumback suggested fixation for bilateral fractures of the humerus[6].

Broad dynamic compression plate was promoted by AO/ASIF for fracture stabilization[39]. They noted complication rates of 7 % hardware failure, 6 % infection, and 5% chances of iatrogenic nerve palsy. This is still considered the gold standard of management of humeral diaphysis fractures.

Kunstcher first proposed intramedullary nailing for management of diaphyseal fractures of the femur, the tibia and the humerus during the World War II. This was further promoted by Maatz[25].

Flexible nails in multiple numbers can be inserted into the humerus from both the antegrade and retrograde entry portal. The nails which have been in use are

- Enders nail[16,22]
- Hacketh nail[17,32]
- Rush nail[6]

They found to be having good prognostic outcome with 3 % chances of infection, 9% chance of nonunion, and rarely migration[32].

Interlocking intramedullary nailing was the obvious sequel for this and the first nail to be introduced was the Seidal's nail[34]. Here the distal locking is achieved by expandable fins, which are opened from within the barrel. This fell into disrepute because of the complications associated with flange failure[14].

Newer developments include Marchetti Vincenzi nail[42], the Russel taylor nail[10], Syntheses design[5]. These nails are associated with post operative shoulder function morbidity[21]. Interlocking nailing has been found useful in treatment of nonunion of fracture of the humerus [27]and pathological fractures of the humerus[13].

SURGICAL ANATOMY[31]

Humerus is one of the four long bone complex of the appendicular skeleton. It forms the single bone scaffold of the arm segment. It is a long tubular bone with a diaphysis and globular proximal metaphysis and a flattened and widened distal metaphysis. It is surrounded by a thick sleeve of muscle, which enhances the vascularity of the bone.

ANATOMY OF THE HUMERUS

Humeral diaphysis constitutes the middle three – fifths of the bone extending from the upper end of the pectoralis major to the supracondylar region.

The diaphysis is circular in cross section in its proximal half and gradually becomes triangular in the distal half. This transition occurs at the mid diaphysis near the insertion of the deltoid.

DIAPHYSIS

The proximal half of the diaphysis is broad and circular in cross section. It is grooved on its anterior aspect by the long head of biceps. In the distal half of the bone flattens out into a triangular cross section. It has an anteromedial and an anterolateral surfaces flanked by medial and lateral supracondylar ridges. It also has a posterior surface. The lower end of humerus in its juxtaarticular region is marked by the fossae to

accomadate the olecranon posteriorly and the coronoid and the radial head anteriorly.

The medullary canal follows the contour of the humeral diaphysis. It is circular in its proximal half and is triangular in its distal half. It is broad proximally and tapers down distally. The medullary canal is straight and is having an anterior offset towards the distal end.

PROXIMAL HUMERAL METAPHYSIS

Proximal humeral metaphysis is the broad globular end of the bone. It has an spheroidal head, which articulates with the glenoid. Apart from this the proximal end also has two bony prominences the greater and the lesser tuberosity. These landmarks are separated from each other by the presence of bicepetal groove. A shallow constriction separates the two tuberosities from the articulating surface. This constriction is the anatomical neck of humerus. This is a significant landmark as the space between the articulating surface and the greater tuberosity forms the entry point for the interlocking nail in antegrade insertion technique.

DISTAL HUMERAL METAPHYSIS

Distal humeral metaphysis broadens mediolaterally and flattens anteroposteriorly. It is made up of the medial epicondyle, the trochlea, the capitelum, and the lateral epicondyle medio-laterally. Between the distal articulating surface and the diaphysis are fossa for accommodating the

olecranon posteriorly and the coronoid and the radial head anteriorly. The distal humeral articulating part is angulated anteriorly to the diaphysis by an angle of 40 degrees to the diaphysial axis in sagitttal plane[23].

The diaphysis is supplied by single nutrient artery arising from the brachial artery in the midshaft level.

SOFT TISSUE RELATIONS

The humerus is surrounded by a bulky sleeve of muscle, which provides for the better vascularity of the bone. There are three important neurovascular bundles, which weave around the humerus, which becomes significant during exposure of the bone.

MUSCULAR RELATIONS

Humerus posteriorly is related to triceps, two of whose heads, lateral and medial, originate from the posterior surface of the bone on either side of the radial groove. Anteriorly it is related to biceps brachii, which does not have any attachment on the humerus, and the brachialis, which orginates from the anterior surface of the lower half of the bone. The deltoid covers the anterior, lateral and posterior aspect of the proximal half of the humerus.

MUSCULAR ATTACHMENTS

To the anatomical neck is attached the shoulder joint capsule and the capsular ligaments. The grater tuberosity gives insertion for the supraspinatus,the infraspinatus and the teres minor from above downwards. Subscapularis gets inserted onto the lesser tuberosity. Pectoralis major, the latissimus dorsi and the teres major gain insertion into the bicepetal groove from before backwards. The deltoid is inserted onto the deltoid tuberosity on the lateral aspect of the middle of the shaft. Corresponding to the insertion of the deltoid, on the medial aspect is the insertion of the corocobrachialis. The anteromedial and anterolateral surfaces in the lower half of the humerus give origin to brachialis. The posterior surface gives orgin to the lateral and medial heads of the triceps above and below the bicepetal groove. The medial and the lateral epicondyles are attached to the common flexor and extensor origin. The lateral supracondylar ridge gives origin for the brachioradialis, extensor carpi radialis longus and brevis.

NEURO VASCULAR RELATIONS

Three important neurovascular bundles flank the humerus in its anatomical relations. The axillary nerve runs around the proximal metaphysis of the humerus supplying the deltoid. It is about an average 4.56 cms [23]from the lateral edge of the acromion. This is important while inserting the proximal locking screw. The radial nerve accompanied by

profunda brachial vessels runs around the posterior aspect of the humerus in the radial groove flanked by the medial and lateral head of triceps. This structure is important in exposure of the humeral diaphysis by the posterior approach. Occasionally it may get entrapped in the fracture ending up with radial nerve palsy. The brachial vessels, median and the ulnar nerve and the medial cutaneous nerves of the arm and the forearm run in the space between the space between the biceps and the brachialis.

APPLIED SURGICAL ANATOMY

- The entry point for humeral interlocking nailing is very close to the passage of bicepetal tendon, which may be irritated if, the nail projects out.
- While exposing the entry point we have to dissect the rotator cuff, which has to be carefully repaired.
- The entry point is intraarticular and hence may be associated with shoulder stiffness.
- The axillary nerve runs at a distance of 4.56 cms[23] from the tip of the acromion. It may be injured while applying the lower of the proximal screws.
- The radial nerve runs very close to the middle two thirds of the bone in the radial groove. It may be injured by the fracture, during reduction, or during exposure by posterior approach.

- The brachialis has a dual nerve supply by the musculocutaneous nerve and the radial nerve. This fact is used while developing the plane during anterolateral approach.
- The canal is almost straight and the entry point is eccentric. This determines the angle in the proximal end of the nail.

CLASSIFICTION

There is no classification for humeral diaphyseal fractures good enough to prognosticate the outcome of treatment. AO/AISF has an elaborate system of classification of the fractures based on fracture morphology, and the fracture site. The comprehensive classification system is of prognostic value, in that the greater the grade of fractures, the higher the energy of injury implying greater the chance of occurrence of complications during treatment.

AO/AISF CLASSIFICTION OF THE HUMERAL DIAPHYSEAL FRACTURES[28]

Type A: Simple fractures

Circumferential break in the bone

A1. = Spiral fractures

.1 in the proximal zone

.2 in the middle zone

.3 in the distal zone

A2.= Oblique fractures- fracture lies at 30 degree or more at the diaphysis

.1 in the proximal zone

.2 in the middle zone

.3 in the distal zone

A3. = transverse fractures- fracture lies at < 30 degree to the diaphysis

.1 in the proximal zone

.2 in the middle zone

.3 in the distal zone

Type B: Wedge fractures

Separate fragment but the fractures reduce with contact between the main fracture fragments

B1. = spiral wedge as a result of torsional force

.1 in the proximal zone

.2 in the middle zone

.3 in the distal zone

B2. = bending wedge as a result of bending stress

.1 in the proximal zone

.2 in the middle zone

.3 in the distal zone

B3. = bending wedge where the wedge is comminuted

.1 in the proximal zone

.2 in the middle zone

.3 in the distal zone

Type C: complex fractures

There are more than two fragments, and even after reduction the two main fragments do not come in contact.

C1. = spiral

.1 in the proximal zone

.2 in the middle zone

.3 in the distal zone

C2.= segmental

.1 in the proximal zone

.2 in the middle zone

.3 in the distal zone

C3. = irregular fractures

.1 in the proximal zone

.2 in the middle zone

.3 in the distal zone

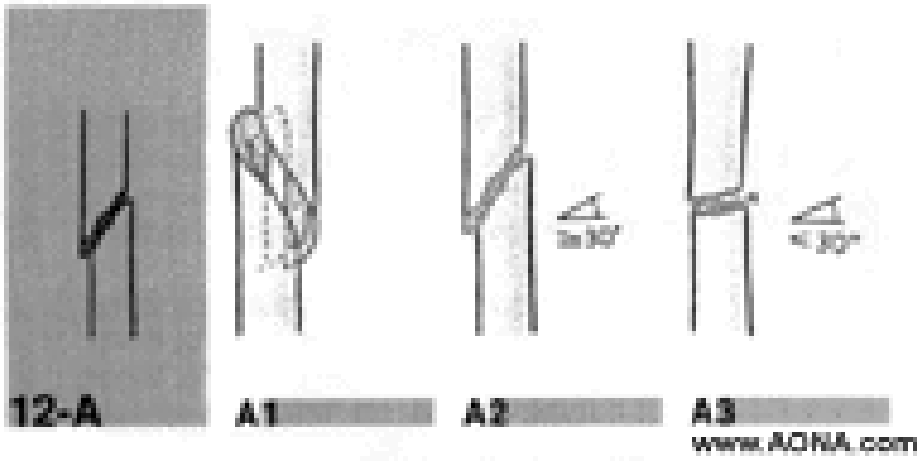
The fractures can also be classified based upon the level of injury with relation to the powerful muscular attachments of the pectoralis major and deltoid.

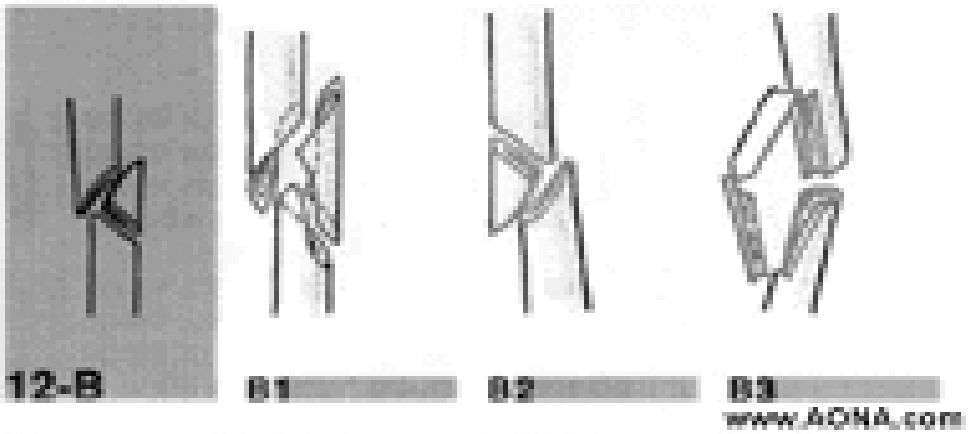
If the fracture lies proximal to the insertion of the pectoralis major there is not much deforming forces as the abductor power of the deltoid and the adductor power of the pectoralis nullify each other on the distal fragment.

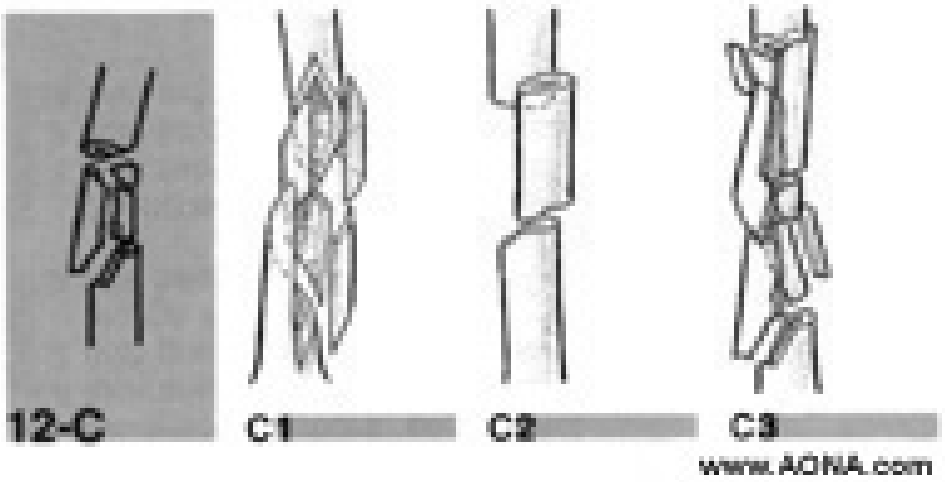
If the fracture line exists between the pectoralis major and the deltoid, then the proximal fragment is adducted and the distal fragment is pulled away resulting in severe malalignment.

If the fracture has occurred distal to the insertion of deltoid then the fracture will go in for varus angulation.

CLASSIFICATION







GENERAL PRINCIPLES OF MANAGEMENT[37]

60 % of the humeral diaphyseal fractures are associated with polytrauma. Hence these systemic problems must be sought after and treated before the definitive management of the humeral fractures.

AVAILABLE TREATMENT OPTIONS

1. Thoraco brachial immobilization
2. closed reduction and hanging arm cast
3. closed reduction and co aptation splint
4. open reduction and internal fixation with
    a) plate osteosynthesis
    b) intramedullary nailing
        i. multiple nails
        ii. flexible nails
        iii. solid nails
5. closed reduction and internal fixation with

A. intramedullary interlocking nailing

6. External fixator application with
    a. AO external fixator
    b. Ilizarov ring fixator

AO/AISF formulated the following treatment guidelines based on Lambotte's principles of surgical management of fractures.

1. Anatomical reduction especially in joint fractures
2. Stable internal fixation to fulfill local biomechanical demands
3. Preservation of blood supply
4. Active pain free mobilization of the limb to prevent the development of joint disease.

BIOMECHANICS OF INTRAMEDULLARY NAILING

Kuntcsher introduced the concept of elastic intramedullary nailing based on the principle of elastic impingement (i.e. radial compliance). The nail, which has a slot, could be compressed while insertion. The nail will expand and occupy the entire medullary canal, once the insertion is complete. This was used in fixation of femur, tibia and the humerus. Even though his concept was successful in treatment of the fractures of the lower limb, it was found not to be effective in treating the humeral diaphyseal fractures.

Further mechanical testing has shown that these nails are stable on the basis of three point fixation rather than radial compliance. Multiple flexible nails have been used in fixation of humeral diaphyseal fractures as they are found to provide rotational stability due to their multiple entry points and due to the multiple nails providing a greater strength.

Significant deforming mechanical stress is exerted on the bone by the muscles getting attached on to it. These stresses may be bending stress, compression stress, rotational stress and distraction stress.

An intramedullary nail being located in the centre of the bone provides rigid temporary stiffness to the bone. It acts as an internal splint and works as a load sharing device. Permitting load transmission across the fracture site and thus promoting fracture healing. These nails are best suited to control the bending and translational stresses. Since it shares the centre of rotation of the bone it is not effective in controlling the rotational stress on the bone. This can be achieved by additional fixations like derotation plates, interlocking screws or pins.

INTERLOCKING NAILS

The introduction of interlocking nail has made the use of unlocked nails obsolete.

STATIC LOCKING AND BRIDGING FIXATION[43]

Screw insertion at the two ends of the humeral nail provides for the rotational stability by interlocking the nail with the proximal and the distal fragment. Interlocking essentially, maintains the bone length and more importantly controls the rotational stability at the fracture site. This is very significant in humerus as the stresses are more of a rotational type

rather than a compression distraction type. Static locking achieves a bridging fixation.

In bridging fixation the implant extends across the fracture site and is fixed to the major proximal and distal bone fragments by locking screws located away from the fracture site. Static locking is effective in treating fractures with severe comminution, delicate soft tissue cover, long oblique or spiral fracture patterns. In these situations it is undesirable to open the fracture site and devascularise the fracture ends.

NAIL LENGTH AND WORKING LENGTH[43]

In working with interlocking nailing, three lengths of nail become significant

- Total nail length
- Length of nail bone contact
- Working length

Total nail length is purely anatomical. Too long a nail can protrude at the point of insertion and thus be intraarticular. It may cause distraction at the fracture site and end up with non-union. Too short a nail length can compromise the fracture fixation.

The length of the nail bone contact reflects the total surface area of contact between the nail and bone. This may provide for the rigidity of nail fixation.

Working length is the most crucial factor in determining the success of the fixation. It is defined as the length of the nail spanning the fracture site from its distal most point of fixation in the proximal fragment. This defines the length of bone carrying the load across the fracture site.

The bending stiffness of a nail is inversely proportional to the square of its working length. The torsional stiffness is inversely proportional to working length. Therefore shorter the working length, stronger the fixation.

LOCKING SCREWS[43]

Strength of the locking screws depends upon the root diameter and the span of the screws between the support points. The screw ends are supported by the two cortices, while the longitudinal load is applied by the nail. Hence the locking screw is loaded at four points. Screws which have threaded portion at one end and solid shaft at the other end have a better strength. Obliquely oriented locking holes prevent medio lateral translation on varus valgus load.

MATERIAL PROPERTIES[33,43]

The material used should be biocompatible to withstand corrosion and of sufficient strength to withstand the stresses. Material properties depend upon the composition of the material, the processing involved, the grain size and the porosity. Different materials have different elastic modulus thus with different tensile strengths. The best suited for fracture fixation being 316L stainless steel and titanium alloy.

316L stainless steel is composed of iron, 17% chromium, 12% nickel, 3% manganese and 2% molybdenum with 0.03% carbon. It has an excellent corrosion resistance. It has a modulus of elasticity comparable to human bone. Titanium alloy is made up of a composite of titanium, aluminum and vanadium. This has got the modulus of elasticity closest to the human bone but is very much corrosion resistant due to the property of formation of oxide film. It has an excellent resistance to fatigue due to cyclical loading.

PRINCIPLES OF FRACTURE FIXATION BY INTERLOCKING NAILING[43]

Interlocking intramedullary nailing is a safe and effective means of fracture fixation. The early mobilization for the neighboring soft tissues and joint is a proof enough for the amount of stability provided by the fixation. This is a biological means of fixation and aims at providing early useful movements of the arm.

Basic concepts associated with interlocking nailing are:

1. It can used to fix any fractures between a point 3 cms from the surgical neck of the humerus to a point 4 cms proximal to the upper limit of the olecranon fossa.

2. Closed nailing must be attempted whenever possible. This is more scientific and biological way of fixing the fracture.

3. Bony union is the primary objective of the surgical procedure. Nail is in no way a good substitute for bony union.

4. Proper dimensions of the nail and instrumentation are essential. Image intensifier control is mandatory.

5. Intramedullary fixation may be complemented with reaming. Use of reaming is based upon the concept of providing a uniform bone implant interface.

INTERLOCKING NAILING VS PLATING

ADVANTAGES

- No periosteal stripping
- Fracture haematoma not disturbed
- Minimal inscison , so chances of infection less

DISADVANTAGES

- Insertion site is intra articular so chances of impingement
- Chances of injury to rotator cuff
- Incidence of nonunion

UNREAMED NAILS

***** Rush nails, Enders nails, Hackethal nail.

* Undreamed humeral nail AO (synthes)

ADVANTAGES

* Lesser operating time.

* Lesser disruption of endosteal blood supply

* Lesser infection rate

* Lesser disruption of the fragments of communition.

DISADVANTAGES

* Only small sized nail can be used

REAMED NAILS

* Cannulated nail system

ADVANTAGES

* Allows use of larger sized implants
* Allows for a better bone implant interface
* The osteogenic potential in the osteoprogenitor cells present in the reaming debris and morcelised bone fragments promote bony union.

DISADVANTAGES

* Improperly reduced eccentric reaming results in splintering and malreduction
* Loss of endosteal blood supply may result in delayed reunion.
* Increases the risk of fat embolism
* Higher infection rates
* Need for a flexible and cannulated reaming system is essential
* Costly equipments and inventory

EFFECTS OF REAMING ON DIAPHYSIAL CIRCULATION [35,36]

Rhenlander et al. studied the effects of reaming on diaphyseal blood flow and bony union. Theoretically, the endosteal vessels supply two-thirds of the diaphyseal cortex. By destroying this blood source, reaming delays osteosynthesis.

Cylindrical tubular bones, which fill the medullary canal further, jeopardize the vascularity by entirely filling the canal. Moreover reaming leaves a layer of necrotic bone material, which fills the space between the bone and the implant creating a large potential sequestrum. Till the revascularization is complete this is potentially a disastrous region for infection. However the intramedullary position of the nail does not hamper the restoration of the endosteal flow.

CONCEPTS OF FRACTURE HEALING BY INTRAMEDULLARY NAILING[43]

Stability of intramedullary fixation and the rotational stability achieved by interlocking the fragments is the mechanical basis for fracture healing. The biological fixation attained by the preservation of the fracture hematoma**,** insertion of the nail without reaming and thus retaining the endosteal vascularity makes union imperative.

Periosteum accounts for the vascularity of outer one-third of the diaphysial cortex. In cases with comminution at the fracture site the soft tissue attachment provides for the vascularity of the comminuted fragments. Open reduction further destroys the blood supply by stripping the periosteum off the bone.

Reaming destroys the endosteum thereby stripping the inner two thirds of the cortex of its blood supply. Thus open reduction and intramedullary fixation is against the concept of biological fixation. The concept of intramedullary interlocking nailing is to preserve the periosteal blood supply and to promote fracture reunion by utilizing the osteogenic potential of the pluripotent cells in the fracture hematoma.

Impaction**,** by providing compression at the fracture site, promotes healing by primary union with the Haversion system establishing continuity across the fracture ends. Humerus being a non-dependant

bone, it is difficult to maintain compression unless the nails are locked in static mode.

In cases with presence of micro motion, the fracture union occurs by abundant endochondral callus formation, the secondary site is acceptable. If the motion is excessive fracture non-union occurs.

Bone grafting promotes fractures union by providing the osteoinductive potential at the fracture site. Barry.L.Reimer et.al.[34] suggested bone grafting for following situations.

- Comminuted fractures
- Cortical defect more than one-third the circumference of the bone
- Persistent gap on follow up
- Potentially unstable fixation
- Devitalized fracture fragments
- Use of stainless steel implants

TREATMENT PROTOCOL

Fractures of the humeral diaphysis are commonly associated with other systemic injuries viz. thoracic injuries, facio maxillary injuries, and injury to the brachial plexus. These more life threatening injuries must be looked for and treated immediately. Any neurovascular involvement, esp. that of radial nerve and the brachial vessels must be checked for.

The humeral diaphysial fractures are treated with closed reduction and coaptation splinting. This can be the definitive treatment if the reduction is satisfactory and there are no vascular complications.

Surgery is contemplated in the following cases.

- Inability to maintain fracture alignment in normal bracing i.e., more than 15^0 of angulation or rotational deformity.
- Non compliance
- Poly trauma
    - Spinal injury
    - Lower extremity injury
    - Long bone fractures involving the same limb
- Pathological fractures

- Brachial plexus injury
- Brachial artery injury
- Bilateral humeral fractures
- Segmental fractures
- Comminuted fractures

PRE OPERATIVE MANAGEMENT

Once the patient is stabilized systemically patient is processed for surgery and the preoperative planning is prepared. The nail size is measured from the radiograph of the normal bone. It is measured between the tip of the greater tuberosity to a point 3 cms proximal to the tip of the olecranon fossa. The best method is by use of a scanogram where the nail of approximate length is tied to the normal arm and a radiograph is taken.

INSRUMENTATION

In spite of the pre operative planning we have to keep ready the whole range of the nail system. The entire instrumentation essential for the insertion and extraction of the nail must be kept available. Image intensifier or a C arm control is also needed.

IMPLANT DESIGN

Humerus interlocking intramedullary nail used by us were made of stainless steel 316L. The nails are available in diameters of 6,7 mm and 8 mm. the 6 mm nail is solid while the larger diameter nails are cannulated. These can be inserted over a 2.4 mm guide wire. These nails are available in varying lengths from 200 mm onwards at an increment of 10 mm. The distal end is blunt and beveled to allow for an easy negotiation of the fracture site. These are provided with a minimal bend of 5^0 at a constant distance from the proximal end to account for the eccentricity of the entry point. The nails would have an internal thread at its proximal end to seat the locking bolt in the jig.

The proximal end of the nail is broadened to accommodate for the thicker locking screws. These slots are circular and provide for static locking. The proximal locking screws are passed from lateral to medial direction. The distal end of the nail is provided with two circular slots for static locking of distal locking screw. These slots provide for an anterior posterior insertion of the locking screw.

The locking screws are 3.9 mm diameter torchar tip, self cutting cortical screws. The distal locking can performed with a jig or by image intensifier control.

INSTRUMENTATION

IMPLANTS

SURGICAL TECHNIQUE

ANTEGRADE HUMERAL NAILING BY CLOSED METHOD

The whole of the affected upper limb and the axilla is prepared. The patient is maintained under general anesthesia for the procedure. The surgery is done with the patient in supine position with a sand bag under the affected shoulder for better exposure of the entry site. The whole arm segment is painted and draped in order to keep the limb free.

ENTRY POINT

Through the lateral approach for the proximal humerus an incision is made. It starts 1 cms. Anterior and lateral to the point of acromion. The incision extends 3 cms distally. This exposes the multi-pinnate deltoid muscle, which is split along its fibres. Care is taken not to damage the axillarey nerve, which is on an average 4.56 cms distal to the acromion. This exposes the white glistering rotator cuff, which has to be split at the tendon of supraspinatus just medial to its insertion into the greater tuberosity. This being a very vascular site heals better. The vascularity may interfere in the field of surgery. This exposes the entry point site just medial to the great tuberosity. This can be seen per operatively as a depression of the anatomical neck. The entry point can also be checked by image intensifier. The entry point is opened up with a sharp awl and reamed up to 9 mm diameter. This prevents the development of hoop

stresses at the entry point while insertion of the nail. The nail whose dimensions have been determined by pre operative radiograph is mounted on to a jig. The size of the nail can be reconfirmed by using a guide pin and checking under an image intensifier.

INSERTION OF NAIL

The nail, mounted on to the jig, is inserted through the entry point into the bone. At the fracture site is negotiated across the fracture ends under the guidance of the image intensifier.6mm nails are solid nails so they are passed directly under the guidance of image intensifier.7/8 mm nails are cannulated so initially guide wire is passed across the fracture, serial reaming done and then the nail inserted. The nail can be tapped in order to push it deep into the humerus so that it does not protrude into the articular surface. Care has to be taken while choosing the nail in order to avoid the over sized nail which may end up in splintering the distal fragment.

DISTAL LOCKING

This is done by image control using a 3.9 mm self-taping screw. Under image guidance the location of the distal locking slot is noted and a stab incision is made on the anterior of the arm. Both the biceps and the brachialis are split to reach the anterior surface of the humerus. Under image control, the bone is drilled using 2.9 mm drill bit and locking is

achieved using 3.9 mm screw passed anteroposteriorly. This can also be achieved using a distal locking jig**.**

PROXIMAL LOCKING

This is achieved by using 3.9 mm self-tapping locking screws. This is applied by using the jig and the screw is passed lateral to medial. Care has to be taken to avoid the axilary nerve, which is situated on an average 4.56 cms distal to the acromion. The screw slot can be predrilled with 2.9 mm drill bit. The fracture site can be compressed by back slapping the nail after insertion of the distal locking screw.

CLOSURE

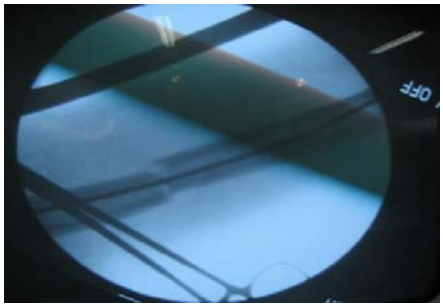
The rotator cuff has to be repaired using a non-absorbable suture. All the wounds are closed in layers. Suction drain must be kept inside the shoulder joint.

Incision

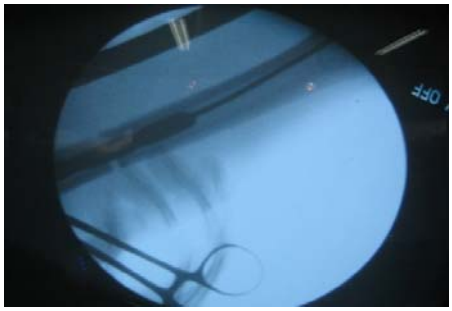
Entry point

Insertion of guide wire

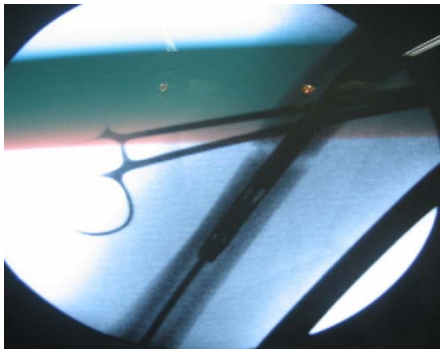
Reaming



Insertion of nail

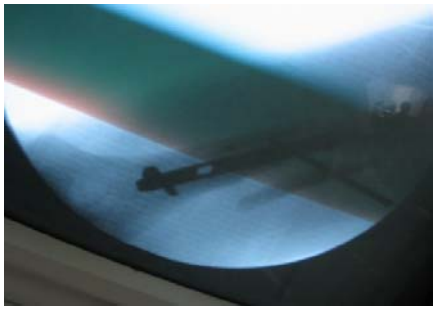


Proximal locking



Free hand technique

Distal locking



RETROGRADE HUMERAL NAILING BY CLOSED TECHNEQUE

This is the more effective technique of humeral nailing, but it is technically more demanding. The patient is positioned on the lateral position or prone position whichever is suitable for the surgeon. The limb can be suspended by an overhead traction. The parts are painted and draped.

ENTRY POINT

The distal end of the humerus is opened by a posterior midline approach. Through a midline incision, which splits the triceps tendon the distal end of the humerus, is exposed. A 3 cms by 1 cm oblong window is created 2.5 to 3 cms prodoxial to the proximal end of the olecranon fossa. Use of a burr promotes the proper formation of the entry point. Care should be taken to prevent the formation of sharp edges to avoid stress raising effect.

INSERTION OF THE NAIL

Same nail, which is used for antegrade nailing, can be used for retrograde nailing. The nail has to be negotiated at the fracture site under image intensifier guidance.

PROXIMAL LOCKING

This is performed under image control using a 3.9mm self-tapping locking screw passed lateral to medial. The slot is predrilled using a 2.9mm drill bit. Care needs to be taken to avoid injury to the joint surface or the axillary nerve.

DISTAL LOCKING

This is done with the help of the jig using a 3.9mm self-tapping screw passed in a posterior to anterior direction.

POST OPERATIVE TREATMENT

Intramedullary interlocking nailing is done with the aim of providing early active mobilization of the limb. Drain tube is removed 48-72 hrs after the surgery. Antibiotics are given up to the fifth postoperative day. Suture removal is done on the tenth postoperative day.

Patient is taught passive and active range of motion exercises for the shoulder and elbow and he is made to perform the same as the pain permits. Active guided mobilization of the shoulder is essential for better rehabilitation. This includes pendular motion exercises, the supported and active abduction exercises involving the shoulder, the circumduction exercise for the shoulder and flexion exercises involving the elbow. Progressive increasing weight lifting can be promoted with time.

Serial radiographs are taken at monthly interval to note for the fracture union.

MATERIALS AND METHODS

Our study was conducted in the Institute of orthopaedics and traumatology, madras medical college from august 2007 to September 2009. It is a case series of 23 diaphyseal fractures in 22 patients. One patient died in the postoperative period and two patient was lost in the follow up so were excluded from the study.

SELECTION CRITERIA

1. Comminuted fractures
2. Segmental fractures
3. Polytrauma
4. Age more than 17 years when the physis is fused
5. The fracture line is 3 cms beyond the surgical neck and 4 cms from the olecranon fossa.
6. compound fractures

EXCLUSION CRITERIA

1. Presence of open physis
2. Grossly contaminated compound fractures
3. Fractures involving the proximal 3 cms and the distal 4 cms of the diaphysis.

AGE DISTRIBUTION

AGE	NO OF PATIENTS
20 – 30	7
31- 40	7
41- 50	8
51-60	-

SEX DISTRIBUTION

MALE	20
FEMALE	2
TOTAL	22

OCCUPATION

LABOURER	12
HOUSEWIFE	2
STUDENT	2
OFFICE GOER	6
TOTAL	22

SIDE

RIGHT	12
LEFT	11
TOTAL	23

MODE OF INJURY

ROAD TRAFFIC ACCIDENT	17
ACCIDENTAL FALL	5
INDUSTRIAL ACCIDENT	-
OTHERS	-
TOTAL	22

SEVERITY OF INJURY

HIGH VELOCITY	9
MODERATE VELOCITY	13
TRIVIAL	-

TYPE OF INJURY

CLOSED	20
OPEN	3

FRAC TURE PATTERN- AO/ASIF CLASSIFICATION

TYPE A	2	A2-2
TYPE B	19	B1-2; B2-16;B3-1
TYPE C	2	C2-2

ASSOCIATED INJURIES

Elbow dislocation	1
Both bone leg fracture	2
Shaft of femur fracture	1
Fracture acetabulum	1
Lunate dislocation	1
Bilateral both bone forearm	1
Lateral humeral condyle fracture	1
Bimalleolar fracture	1
Compound Monteggia fracture	1

FRACTURE FIXATION

- Antegrade interlocking humerus nailing was done in all cases.
- Fracture reduction was achieved by closed method with the help of C-ARM.
- Grossly comminuted and segmental fractures were protected in the initial month by proper splintage.

OBSERVATION

- Most of the patients were in the age group of 20- 40 years of age.
- Male preponderance was found in series with a male to female ratio of 10: 1.
- Most of the affected individuals were manual labourers.
- Road traffic accident was the most common cause accounting for 17 of the 22 cases in our series.
- Both sides were affected almost equally in our series.
- AO/ASIF TYPE B2 fractures were the most frequent fracture pattern noticed in our study.
- Most of the injuries were due to moderate velocity injury.
- Among all the fractures 21 were closed while 2 were open injuries.
- Thirteen of the twenty three patients and other associated injuries which needed surgical management.

OUTCOME

Of the 22 patients treated in our study one case died in immediate post operative period due myocardial infarction and two cases were lost in follow up. The 19 cases were followed up over an average period of 16.6 weeks (range 10- 24 months).

FOLLOW UP

MINIMUM	10
MAXIMUM	24
AVERAGE	16.6

UNION

Of the 20 fracture shaft humerus fractures fixed with interlocking nailing who came for follow up, 15 fractures united in 12 weeks. Three fractures went in for non-union for which implant exit plate osteosynthesis and bone grafting was done. One case showed delayed union as there was some distraction at the fracture site.

Normal union	16
Delayed union	1
Non union	3

The average period for union of the fracture was 12.6 weeks (range 11- 15 weeks).the one case of delayed union united at 18 weeks. The non union cases were treated with implant exit, plate osteosynthesis and bone grafting following which the fracture attained normal union.

COMPLICATIONS:

Various complications were encountered during and after surgery.

NON UNION	3(15%)
DELAYED UNION	1(5%)
FAILURE TO DO DISTAL LOCKING	2(10%)
SUPERFICIAL INFECTION	1(5%)
BREAKAGE OF DRILL BIT WHILE LOCKING	1(5%)
BENDING OF SCREW	1(5%)
GROSS DISABILITY OF SHOULDER FUNCTION	1(5%)
GROSS DISABILITY OF ELBOW FUNCTION	1(5%)

SHOULDER FUNCTION

Of the 20 fractures of humerus treated, 16 cases attained near normal range of motion. Of the remaining four cases one patient had gross restriction of shoulder movement while the other three had minimal restriction of shoulder movement.

Three of the 20 cases treated by locked intramedullary nailing had the proximal end projecting beyond the proximal articular surface. One of these cases had gross restriction of movement while the other two had some restriction.

Of the 20 fractures, 17 gained near normal range of elbow function. All the three with elbow restriction had elbow pathologies. One case had compound Monteggia fracture which was treated with external fixator. One case had posterior elbow dislocation which was treated with casting. And the third case had a lateral humeral condyle fracture treated by cancellous screw fixation.

FUNCTIONAL DISABILITY

GROSS RESTRICTION OF SHOULDER MOVEMENT	1
MINIMAL RESTRICTION OF SHOULDER MOVEMENT	3
RESTRICTION OF ELBOW MOVEMENT	3
PAIN IN SHOULDER WHILE DOING HEAVY MANUAL LABOR	5

Of the 20 fractures 12 had no pain in the shoulder, 5 had pain after doing heavy manual labor while 3 had moderate pain and disability of the shoulder joint.

DASH SCORE:

The functional outcome was assessed based on the DASH score. The best score was 4.5, while the worst score was 36.4. The average score was 12.5(range 4.5 – 36.4).The average indicates to be a good score for humerus fracture fixation

Score	Number of cases
4.5	1
6.8	4
9.1	2
11.4	6
13.6	2
15.9	2
18.2	2
36.4	1

DISCUSSION

The results of the use of intramedullary interlocking nailing for the diaphyseal fractures of the humerus has been mixed, with some studies showing good outcome and some showing not so good outcome. In most studies a significant percentage of patients do not return for follow up once the limb is functional and painless[40]. Non union and functional disability of the shoulder are the most common complaints in most patients postoperatively in many series.

In our series 17 of the 20 fractures united (15%) while three cases went for nonunion. Two cases had delayed union. Of the three cases two fractures had distraction at the fracture site, while one of the fractures distal locking was not done due to technical difficulties. In these cases distraction at the fracture site acted against fracture union. Two cases which went for delayed union both were compound fractures, one of them was segmental fracture which done 3 months later after initial management with external fixator. Our union rate was 85%, which is in accordance with some international studies which mention a union rate of 80-100%[5,9,10,27]. On the other hand plate osteosynthesis gives a fracture union of 93-98%[15,30.41], while functional bracing for the humerus show a union rate of 97-100%[29,40,41]. Maybe our study had higher rate of nonunion because we took only segmental and comminuted fractures in our study.

The average time of union in our series was 12.6 weeks (11-15 wks).this is comparable to other series, which show a union time of 12.3 weeks to 16 wks[1,11,21]. In plate osteosynthesis also the union was achieved between 12 to 18 wks[9,26]. On the other various studies on functional bracing show an average time of 11.5 weeks for the evidence of clinical and radiological union[40].

Faster union rates were noticed when closed reduction and unreamed nailing was done which preserved the vascularity of the fracture site. Static locking system when used along with compression of the fracture site, achieved by reverse banging of the nail after distal locking screw insertion, resulted in a better union rate.

In a randomized controlled trial of 84 patients with humeral diaphyseal fractures treated at random by plate osteosynthesis and by locked intramedullary nail Chapman et al [9]noticed predictable outcome in the results on comparison. 93% patients in the plate osteosynthesis healed within 16 weeks while 87% in the nailing group healed in that time. Shoulder pain and decrement in the range of movement was significant finding in the nailing group in comparison to the plating group. Paris et al noted radial nerve palsy to be significantly increased in plate osteosynthesis.

In our series none of the cases developed iatrogenic nerve palsy. The one case with posterior interosseous nerve palsy was due to

associated both bone forearm fracture for which open reduction and internal fixation with ADCP was done. This corresponds to the other international studies on locked nailing which show a rate of iatrogenic injury between 0-4%[5,9,10].This compares favorably with plate osteosynthesis, which consistently has a higher rate of radial nerve injury[26]. Number of radial nerve palsy is significantly lower in intramedullary nailing than in plating[5]. The superiority in this aspect is attributable to the closed technique of reduction and internal fixation, which prevents the exposure of the radial nerve. This accounted for nil incidence of radial nerve palsy.

One case developed superficial wound infection, which is consistent with other international studies[5]. It settled by intravenous antibiotics. This can be attributed to the lesser exposure time, smaller incision, closed reduction and lesser bulk of the implant used.

Iatrogenic nerve injury and postoperative wound infection are the two complications where the nailing scores over plate osteosynthesis.

16 of the 20 cases of fracture shaft of humerus attained near normal range of motion of the shoulder joint i.e. less than 20 degrees of restriction of motion of the shoulder joint[5,10,12,27].It was observed that the movements and functional ability of the shoulder depended on the level of proximal end of nail, consolidation of the fracture site and the rehabilitation programme used. Four of the patients treated with

interlocking nailing had the proximal end of the nail projecting beyond the proximal joint surface, of which three had some restriction of movement.

The impingement at the shoulder joint can be overcome by impacting the nail deep into the bone before locking the nail. Care has to be taken to properly repair the rotator cuff. Delay in regaining the motion and restricted motion was noticed in cases with inadequate repair of the rotator cuff. None of the cases had any evidence of shoulder instability postoperatively. One case had severe restriction as the nail was protruding out and impinging on the rotator cuff.

17 of the 20 cases had almost full range of elbow motion. All the three cases had associated elbow injuries. One case had compound Monteggia fracture treated by elbow spanning external fixator. One case had lateral humeral condyle fracture fixed with cancellous screws. The third case had a concomitant posterior elbow dislocation for which closed reduction was done. In antegrade insertion technique since the triceps mechanism is least involved there was no restriction in the range of motion of the elbow.

All operative procedures achieve good alignment of the fractured bones. While in 13% of patients treated by functional bracing ended up with cosmetically unacceptable angulation more than 15 degrees[40]. This ratio was more than 50% in those treated with co aptation splinting. As

the nail is used as an internal splinting device there was no evidence of malalignement of the fracture. Interlocking nailing provides both rotational and axial stability to the fracture site. Interlocking nailing helps to maintain the length of the bone in grossly comminuted and segmental fractures though it is not of much significance in upper limb fractures.

9 of the 20 patients were polytrauma patients. In polytrauma patients a procedure which is fast effective and produces minimal blood loss is needed. Closed interlocking nailing is ideal in these conditions as they can be done quickly with minimal blood loss. Hence it is a safe effective and rapid method in polytrauma patients.

The insertion area of the rotator cuff being highly vascular, hemostasis must be achieved for easier identification of the entry point. Proper repair of the rotator cuff is necessary to prevent future shoulder pain. Difficulty was noticed in the insertion of the distal locking screw due to sloping contour of the anterior surface of the distal humerus. this was further complicated by the muscle bulk of the biceps and brachialis , which interfere with distal locking mechanism. Use of image intensifier control is essential to have a lesser operating time and better functional results. None of the cases, which were treated, developed axillary nerve deficit as a complication. Care was taken not to impact the nail too deep into the proximal fragment, in order to avoid damage to axillary nerve.

Post operative mobilization of the shoulder and elbow was very critical in attaining the amount of movements of the shoulder. Patients who adhered to the mobilization programme had a better functional result compared to others.

CONCLUSION

Locked intramedullary nailing is a novel treatment option for diaphyseal fractures of the humerus. It is ideal in treating diaphyseal fractures of the humerus in patients with osteoporosis and polytrauma where reduction in operating time and early rehabilitation are primary objective. It also useful in comminuted and segmental humeral fractures wherein done by closed method, the periosteum is not stripped and the fracture haematoma not violated leading to better and faster fracture healing.

The concept of biological fixation in terms of unreamed nailing, closed reduction, static locking and fracture site compression promotes early and adequate fracture union. Locked intramedullary nailing is an alternative in treating patients with pathological fractures of humerus.

The closed humeral nailing is especially advantageous in comminuted and segmental humeral fractures. Complication like iatrogenic radial nerve palsy and infection is negligible and has not occurred in our series. This is because of closed reduction and minimal soft tissue exposure which is important for fracture healing and early rehabilitation.

The problem of shoulder impingement can be reduced by making correct entry point, placing the nail flush with the bone at the entry site,

adequate repair of the rotator cuff, and by educated motivated rehabilitation program, which promotes good functional outcome.

The problem of nonunion can be avoided by selecting appropriate size nail, avoiding distraction at fracture site, static locking and reverse banging the nail to reduce distraction. These factors will reduce nonunion rate and promote faster healing.

Locked humeral intramedullary nailing is an effective and safe alternative for the treatment of diaphyseal humeral fractures. It is suitable for treatment in patients with comminuted, segmental, polytrauma, osteoporosis and pathological fractures. It provides early rehabilitation and lessens morbidity.

CASE ILLUSTRATIONS

CASE 1

NAME: Puniyakodi IP NO: 86502

AGE: 29 yrs OCCUPATION: Labourer

Date of Injury: 19/12/07 Date of Surgery: 27/12/07

Diagnosis: fracture shaft of humerus

AO/ASIF: Type C2 (segmental fracture)

ASSOCIATED INJURIES: nil

PROCEDURE DONE: closed humeral interlocking nailing

COMPLICATIONS: nil

SECONDARY PROCEDURE: nil

FUNCTIONAL OUTCOME

TIME OF UNION	**14 WEEKS**
MOVEMENT OF SHOULDER	160^0
MOVEMENT OF ELBOW	110^0
PAIN IN SHOULDER	NIL
DASH SCORE	9.1

Pre op

Immediate post op

Follow up

CASE ILLUSTRATIONS

CASE 2

NAME: Sudhakar IP NO: 74692

AGE : 21 yrs OCCUPATION: student

Date of Injury: 31/10/07 Date of Surgery: 12/11/07

Diagnosis: fracture shaft of humerus

AO/ASIF : Type B2(bending wedge fracture)

ASSOCIATED INJURIES: lunate dislocation

PROCEDURE DONE: closed humeral interlocking nailing

Open reduction and k wire fixation for lunate dislocation

COMPLICATIONS : nil

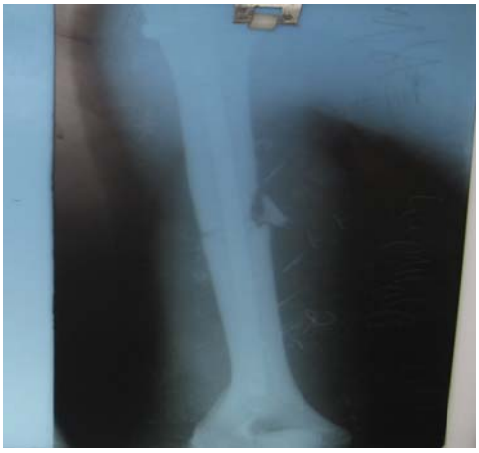
SECONDARY PROCEDURE: nil

FUNCTIONAL OUTCOME

TIME OF UNION	12 WEEKS
MOVEMENT OF SHOULDER	170^0
MOVEMENT OF ELBOW	110^0
PAIN IN SHOULDER	On doing heavy manual labor
DASH SCORE	15.9

Pre op

Immediate post op



Follow up

CASE ILLUSTRATIONS

CASE 3

NAME: Madhu IP NO: 6324

AGE : 28yrs OCCUPATION: clerk

Date of Injury: 24/1/08 Date of Surgery: 4/2/08

Diagnosis: fracture shaft of humerus; bilateral both bone forearm

AO/ASIF : Type B2(bending wedge fracture)

ASSOCIATED INJURIES: bilateral both bone forearm

PROCEDURE DONE: closed humeral interlocking nailing

Open reduction and internal fixation with ADCP

COMPLICATIONS : posterior interosseous nerve palsy on right side

SECONDARY PROCEDURE: nil

FUNCTIONAL OUTCOME

TIME OF UNION	14 WEEKS
MOVEMENT OF SHOULDER	160^0
MOVEMENT OF ELBOW	110^0
PAIN IN SHOULDER	NIL
DASH SCORE	18.2

Pre op

Immediate post op

Follow up

CASE ILLUSTRATIONS

CASE 4

NAME: velayutham IP NO: 52521

AGE : 37yrs OCCUPATION: labourer

Date of Injury: 4/8/07 Date of Surgery: 12/8/07

Diagnosis: fracture shaft of humerus

AO/ASIF : Type B2(bending wedge fracture)

ASSOCIATED INJURIES: nil

PROCEDURE DONE: closed humeral interlocking nailing;

COMPLICATIONS : superficial infection

SECONDARY PROCEDURE: nil

FUNCTIONAL OUTCOME

TIME OF UNION	12WEEKS
MOVEMENT OF SHOULDER	170^0
MOVEMENT OF ELBOW	120^0
PAIN IN SHOULDER	NIL
DASH SCORE	11.4

Pre op

Immediate post op

Follow up

CASE ILLUSTRATIONS

CASE 5

NAME: Balaji IP NO: 61622

AGE : 32yrs OCCUPATION: Labourer

Date of Injury: 19/8/08 Date of Surgery: 11/9/08

Diagnosis: fracture shaft of humerus

AO/ASIF : Type B2(bending fracture)

ASSOCIATED INJURIES: fracture shaft of femur

PROCEDURE DONE: closed humeral interlocking nailing; interlocking nailing for fracture shaft of femur

COMPLICATIONS : fracture shaft of femur went for nonunion for which bone grafting was done.

SECONDARY PROCEDURE: nil

FUNCTIONAL OUTCOME

TIME OF UNION	12 WEEKS
MOVEMENT OF SHOULDER	160^0
MOVEMENT OF ELBOW	110^0
PAIN IN SHOULDER	Pain on heavy manual labor
DASH SCORE	6.8

Pre op

Immediate post op

Follow up

COMPLICATIONS

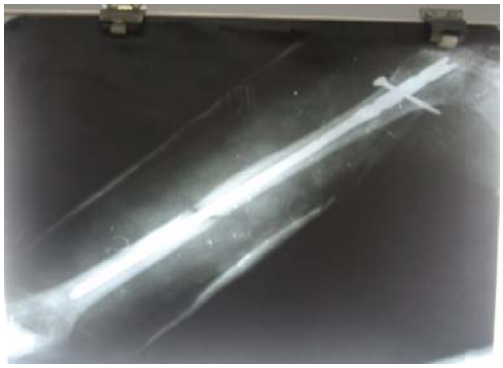
NONUNION

PLATING WITH BONE GRAFTING

NAIL IMPINGEMENT

SHOULDER MOVEMENT RESTRICTION

FRACTURE DISTRACTION AND NO DISTAL



INSTITUTIONAL ETHICAL COMMITTEE
MADRAS MEDICAL COLLEGE,CHENNAI-600 003.

Telephone : 25363970

Fax :044 – 253-5115
:044 25363970

L.Dis.No. 14597/MES/EthicsDean/MMC/2009 Dated .09.2009

Title of the work : "Closed Humeral Nailing in comminuted and Segmental Humerus Fractures out come Analysis"
Principal Investigator : Dr. S. Ashok.
Department : PG MS Orthopaedics
Madras Medical College Ch-3.

The request for an approval from the Institutional Ethical Committee(IEC) was considered on the IEC meeting held on 23rd September 2009 at 2.00P.M. in Madras Medical College, Deans, Chamber, Chennai-3/ Pharmacology Seminar Hall, Madras Medical College Ch-3.

The members of the Committee, the Secretary and the Chairman are pleased to approve the proposed work mentioned above, submitted by the principal investigator.

The principal investigator and their term are directed to adhere the guidelines given below:

1. You should get detailed informed consent from the patients/participants and maintain confidentiality.
2. You should carry out the work without detrimental to regular activities as well as without extra expenditure to the Institution or Government.
3. You should inform the IEC in case of any change of study procedure, site and investigation or guide.
4. You should not deviate form the area of the work for which I applied for ethical clearnance.
5. You should inform the IEC immediately, in case of any adverse events or serious adverse reactions.
6. You should abide to the rules and regulations of the institution(s).
7. You should complete the work within the specific period and if any extension of time is required, you should apply for permission again and do the work.
8. You should submit the summary of the work to the ethical committee on completion of the work.
9. You should not claim funds from the Institution while doing the work or on completion.
10. You should understand that the members of IEC have the right to monitor the work with prior intimation.

SECRETARY
IEC, MMC,CHENNAI

CHAIRMAN
IEC MMC CHENNAI

DEAN 21/10/09
MADRAS MEDICAL COLLEGE
CHENNAI

MASTER CHART

S. No	Name	Age/ sex	Occupation	DOI	DOS	AO TYPE (1.2.)	Ass injury	Follow up (months)	Complica-tion	Time of union (weeks)	Function			DASH score
											Shoulder-abd	Elbow -flx	Pain in shoulder	
1	Velayutham	26y/ m	Labourer	1/8/07	13/8/07	R-A3 L-B2	Nil	24	Non-union left humerus	R- 14 L- 30	R-170 L-160	R-130 L-130	R-nil L-mild	R-4.5 L-6.8
2	Velayutham	37/m	Labourer	4/8/07	12/8/07	B2	Nil	24	Nil	14	170	120	Mild	11.4
3	Subbaiah	45/m	Farmer	2/9/07	3/9/07	B2	Nil	Lost	Nil	-	-	-	-	-
4	Sudhakar	21/m	Student	31/10/07	12/11/07	B2	Lunate dislocation	20	Nil	12	160	120	Nil	15.9
5	Sadasivam	26/m	Labourer	7/11/07	9/12/07	B2	Nil	20	Nil	14	170	120	Nil	11.4
6	Sivakumar	48/m	Labourer	17/12/07	31/12/07	B3	Fracture BB leg	-	Post op MI-death	-	-	-	-	-
7	Puniyakodi	29/m	Labourer	19/12/07	27/12/07	C2	Nil	20	Nil	14	160	110	Nil	9.1
8	Madhu	28/m	Labourer	24/1/08	4/2/08	B2	b/l #BB forearm	18	Post interosseous n. Palsy	12	160	120	Nil	18.2
9	Shantha	45/f	Housewife	16/11/07	13/2/08	C2	GrIII comp # monteggia	18	Stiff elbow	16	90	30	Moderate	36.4
10	Arunagiri	44/m	Labourer	23/1/08	14/2/08	B2	Nil	18	Non-union # humerus	24	160	120	Nil	11.4
11	Sathish kumar	28/m	Labourer	4/3/08	15/3/08	B2	Nil	17	Non-union # humerus	-	170	130	Mild	15.9
12	Lakshmi	25/f	Housewife	3/4/08	12/4/08	B2	Nil	16	Nil	14	160	120	Mild	13.6
13	Gomagan	26/m	Labourer	7/4/08	20/5/08	B2	Raw area L thigh	15	Nil	15	170	130	Nil	6.8
14	Raju	42/m	Labourer	10/5/08	22/5/08	B2	Nil	15	Nil	12	170	120	Nil	6.8
15	Saleem	50/m	Tailor	1/5/08	3/6/08	B2	Bimalleolar #(l) Bb leg #(r)	14	Nil	14	160	120	Nil	11.4
16	Venkatesan	45/m	Labourer	31/7/08	1/8/08	B2	Nil	12	Nil	12	170	130	Mild	13.6
17	Ganesan	31/m	Taxi driver	14/8/08	26/8/08	B2	# lat condyle humerus	12	Nil	12	170	100	Nil	11.4

18	Balaji	32/m	Labourer	19/8/08	11/9/08	B2	# SOF	11	Nil	14	160	120	Mild	6.8
19	Loganathan	35/m	Labourer	15/8/08	16/9/08	C2	# acetabulum	11	Nil	14	160	120	Mild	18.2
20	Patchiappa	40/m	Labourer	28/8/08	17/9/08	B2	Nil	11	Nil	12	170	120	Mild	11.4
21	Elumalai	38/m	Labourer	22/10/08	24/10/08	A3	Breakage of drill bit-retrieved	10	Nil	14	160	120	Nil	9.1
22	Malakondaiya	27/m	Farmer	25/1/09	7/2/09	B2	Post disloc elbow	Lost	Nil	-	-	-	-	-

Date of completion

The Disabilities of the Arm, Shoulder and Hand Score(QuickDash)

Clinician's name (or ref) **Patient's name (or ref**

INSTRUCTIONS: This questionnaire asks about your symptoms as well as your ability to perform certain activities. Please answer *every question* , based on your condition in the **last week**. If you did not have the opportunity to perform an activity in the past week, please make your *best estimate* on which response would be the most accurate. It doesn't matter which hand or arm you use to perform the activity; please answer based on you ability regardless of how you perform the task.

Please rate your ability to do the following activities in the last week.	**No difficulty**	**Mild difficulty**	**Moderate difficulty**	**Severe difficulty**	**Unable**
1. Open a tight or new jar	☐	☐	☐	☐	☐
2. Do heavy household chores (eg wash walls, wash floors)	☐	☐	☐	☐	☐
3. Carry a shopping bag or briefcase	☐	☐	☐	☐	☐
4. Wash your back	☐	☐	☐	☐	☐
5. Use a knife to cut food	☐	☐	☐	☐	☐
6. Recreational activities in which you take some force or impact through your arm, shoulder or hand (eg golf, hammering, tennis, etc)	☐	☐	☐	☐	☐
	Not at all	**Slightly**	**Moderately**	**Quite a bit**	**Extremely**
7. During the past week, *to what extent* has your arm, shoulder or hand problem interfered with your normal social activities with family, friends, neighbours or groups?	☐	☐	☐	☐	☐

	Not limited at all	Slightly limited	Moderately limited	Very limited	Unable
8. During the past week, were you limited in your work or other regular daily activities as a result of your arm, shoulder or hand problem?	☐	☐	☐	☐	☐
Please rate the severity of the following symptoms in the last week	**None**	**Mild**	**Moderate**	**Severe**	**Extreme**
9. Arm, shoulder or hand pain	☐	☐	☐	☐	☐
10. Tingling (pins and needles) in your arm, shoulder or hand	☐	☐	☐	☐	☐
	No difficulty	**Mild difficulty**	**Moderate difficulty**	**Severe difficulty**	**So much difficulty i can't sleep**
11. During the past week, how much difficulty have you had sleeping because of the pain in your arm, shoulder or hand?	☐	☐	☐	☐	☐

The Disabilities of the Arm, Shoulder and Hand (quickdash) Score 0

(**NB.** A DASH score may not be calculated if there are greater than 1 missing items.)

PROFORMA

CLOSED HUMERUS IL NAILING

Case no. **Unit:**

Name: **Age/Sex:**

I.P.No: **Occupation:**

Address: **Phone No.**

Date of Injury:

Date of admission:

Date of definitive surgery:

Date of Discharge:

Mechanism of Injury:

- ☐ Road traffic accident
- ☐ Accidental fall
- ☐ Industrial accident
- ☐ Assault with weapons
- ☐ Others

Severity of Injury:

- ☐ High velocity
- ☐ Moderate velocity
- ☐ Trivial

Hemodynamic status:

- ☐ Stable
- ☐ Transiently unstable
- ☐ Unstable

Side involved: RIGHT/LEFT

Type of injury: CLOSED/OPEN

AO/ASIF CLASSIFICATION OF THE HUMERAL DIAPHYSEAL FRACTURES:

TYPE A: SIMPLE FRACTURES

- ☐ A1: Spiral #
- ☐ A2: Oblique #
- ☐ A3: Transverse #

TYPE B: WEDGE FRACTURES

- ☐ B1: Spiral wedge #
- ☐ B2: bending wedge #
- ☐ B3: bending wedge, with wedge communition #

TYPE C: COMPLEX FRACTURES

- ☐ C1: Spiral #
- ☐ C2: Segmental #
- ☐ C3: Irregular #

Associated other long bones injuries :(YES/NO)

Associated Head injury: (YES/NO)

TREATMENT HISTORY

Date of surgery:

Duration of Surgery:

Nail size:

Proximal locking screw:

Distal locking screw:

Blood transfusion: (yes/no)

Other fracture fixation:

Intra operative complication:

Immediate post operative complication:

Late post operative complication:

FOLLOW UP:

DATE:

COMPLAINTS:

WOUND:

X-RAY FEATURES:

RANGE OF MOBILITY:

ADVICE:

ASST. SIGN

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